NEW RECORD AND RANGE EXTENSION FOR *CERACLEA RESURGENS* (TRICHOPTERA: LEPTOCERIDAE) FROM COLORADO, WITH NOTES ON ECOLOGICAL CONDITIONS[1]

Scott J. Herrmann[2]

ABSTRACT: The western form of the caddisfly *Ceraclea resurgens* (Trichoptera: Leptoceridae) is recorded for the first time from Colorado. This record represents a major southward extension of the known range of this species. Physical, chemical, and biological conditions are described for a unique lotic microhabitat utilized by *C. resurgens* to generate a large localized population. *Glyptotendipes lobiferus* (Diptera: Chironomidae), previously reported from the Great Plains of Colorado, is associated with *C. resurgens* and is reported from the Grand Lake site in the southern Rocky Mountains.

Fourteen males and 20 females of *Ceraclea resurgens* (Walker) were hand picked from the concrete walls inside the west portal gate house of the Adams tunnel aqueduct (Figs. 1 and 2) in Grand County, Colorado (altitude 2550 mamsl; T3N, R57W, S9) on 1 August 1984. One male was also collected at an ultraviolet light from the Yampa River at Sunbeam, Moffat County, Colorado (altitude 1789 mamsl; T7N, R96N, S21) on 25 July 1984. Both collection sites are located west of the continental divide (Fig. 3). Dr. John C. Morse subsequently verified the identification of these caddisfly specimens as the "western form" of *C. resurgens* as illustrated in his 1975 publication. Morse (1987, pers. comm.) reported previously examining specimens of the "western form" from Minnesota, Manitoba, Saskatchewan, British Columbia, Northwest Territories, and Oregon, but none from locations as far south as Colorado. Three other species of *Ceraclea* were previously reported from Colorado by Herrmann *et al.* (1986).

Of the two new record sites, the Adams tunnel gate house location is unusual in several ways. In 1947 the Adams tunnel began carrying transmountain diversion water from west of the continental divide at Grand Lake (altitude 2550 mamsl) to east of the divide at Marys Lake (altitude 2451 mamsl) as part of the U.S. Bureau of Reclamation's Colorado - Big Thompson Project. Before 1947 Grand Lake, the largest and deepest natural lake in Colorado and at the headwaters of the Colorado River drainage system in the southern Rocky Mountains, had a continuous natural outlet at the west end (Nelson, 1971; Pennak, 1955). Today the Adams tunnel intake structure is the "outlet" for Grand Lake.

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[2]Department of Life Sciences, University of Southern Colorado, Pueblo, CO 81001-4901

The intake structure is fan-shaped with an outer curved perimeter of 54.0 m, a radius of 46.6 m, and a vertical opening of 1.2 m. The perimeter opening of the intake structure is covered by 16 fish screens which must be cleaned of algal growth every second or third year. Water flows from the intake structure via paired juxtaposed covered conduits 3.0 m wide, 3.4 m high, and 56.0 m long to a ground level concrete gate house (7.3 m wide and 11.0 m long) containing two radial gate valves which regulate the volume of water being sent through the Adams tunnel (3.0 m diameter; 21.1 km length) to Marys Lake. A continuous vertical air space of 610 to 910 cm exists from the gate house to near the perimeter of the intake structure. This air space permits fecundated females of *C. resurgens* to fly over and oviposit into the water flowing through the covered conduits and most of the intake structure to the gate house. Resh (1976a, 1976b) reported *C. resurgens* to release eggs over the water surface of streams and creeks with flight activity restricted to June. At the Adams tunnel and Yampa River sites conditions are favorable for oviposition over flowing water. Collections of adults from inside the gate house were attempted in mid and late June, but with negative results. Adult emergence and flight activity of Colorado forms of this species appears delayed until late July and early August.

Fig. 1 Adams tunnel gate house site with photographer facing south toward Grand Lake. Intake structure and conduits to gate house are buried under paved roadway and parking area at the right side of the picture. Photo by G.F. Price.

Ceraclea resurgens larvae were reported by Resh *et al.*(1976) to be obligate consumers of freshwater sponge. Lehmkuhl (1970) described how larvae of *C. resurgens* had ingested tissue of the sponge *Ephydatia muelleri* (Lieberkuhn) in the Red Deer River near Hudson Bay, Saskatchewan. Four species of freshwater sponge were reported for Colorado by Williams (1980); *E. muelleri* inhabits mountain lakes both east and west of the continental divide and displays a high tolerance to a wide range of water quality conditions. Personnel of the U.S. Bureau of Reclamation report that no one has been permitted into the intake structure and covered conduits to inspect or clean their surfaces since the Adams tunnel started carrying water in 1947. It is assumed larvae of *C. resurgens* are consuming tissue of a species of freshwater sponge, unknown at this time, while co-inhabiting the intake structure and/or conduits leading to the gate house. Sufficiently large growths of freshwater sponge must exist in the intake structures and/or conduits to support the feeding habits of larvae since the total of 34 adults hand picked from the inside gate house walls represented only about 5% of the total number observed on the ceilings, conduit walls, and inaccessible aqueduct structures.

A chemical and biological profile of the water entering the Adams tunnel is useful in characterizing the ecological conditions under which *C. resurgens* and associated sponge are thriving. Monthly mean and stan-

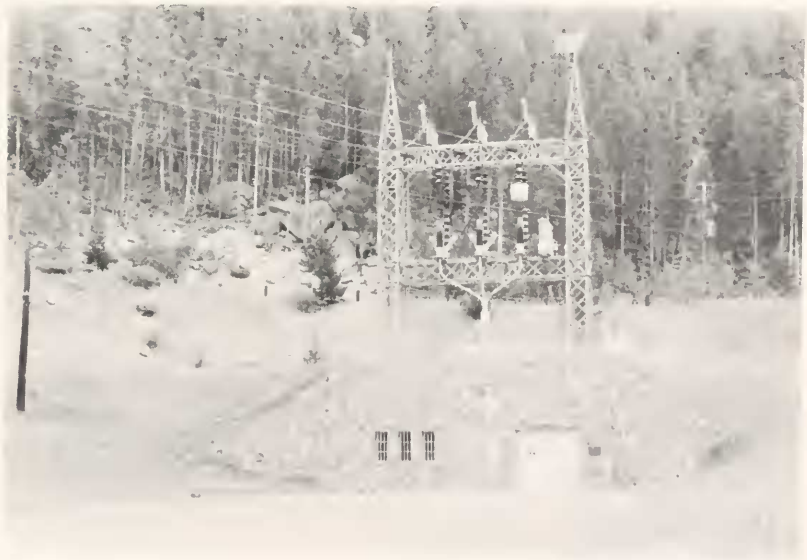

Fig. 2. Adams tunnel gate house structure at West Portal with photographer facing north. Photo by S.J. Herrmann.

dard deviation values for major anions, cations, and other physicochemical parameters are summarized in Table 1 for water passing through the intake structure, gate house, and Adams tunnel during the 11 year period 1977 - 1987. Mean monthly temperature was lowest in January (1.8°C) and highest in August (15.6°C). Concentrations of dissolved calcium, magnesium, sodium, potassium, sulfate, bicarbonate, and chloride were at a minimum during the summer months of July and August and at a maximum during late winter and early spring. Dissolved silica levels were highest in May and lowest in August. The micronutrient content of Grand Lake water entering the Adams tunnel is cited in Table 2. Concentrations of various forms of nitrogen and phosphorus are sufficiently high to describe Grand Lake as being mesotrophic (U.S. Environmental Protection Agency, 1977a). Nelson (1971) reported that essentially all primary productivity occurred in the upper 6 m of Grand Lake.

In addition to *C. resurgens* being collected from the inside of the Adams tunnel gate house, the chironomid *Glyptotendipes lobiferus* (Say) was numerous with 17 males and 2 females being captured on 1 August 1984 from the interior of the same structure. According to Sublette (1988, pers. comm.), the only other Colorado record for *C. lobiferus* is from Peetz

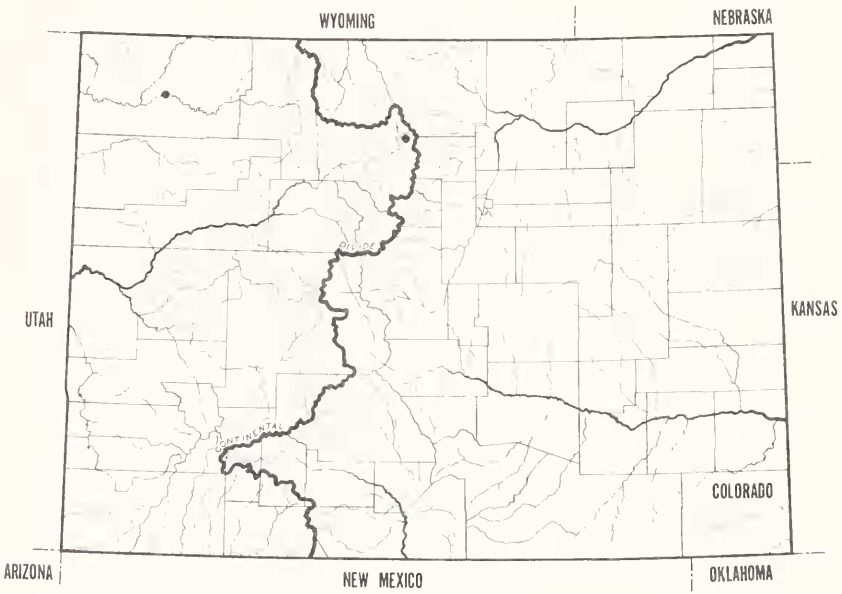

Fig. 3. Collecting sites constituting new record of *Ceraclea resurgens* in Colorado. Solid circles mark the two locations.

Table 1. Concentrations and values of major anions, cations, and limnological parameters for water conducted through the Adams tunnel from 1977 to 1987. Data were calculated from U.S. Geological Survey (1977-1987) and are cited as the mean ± 1 standard deviation with n = 11 for most months

Month	Temperature Degree C	Specific Conductance µs/cm	Alkalinity mg/L as $CaCO_3$	Dissolved Sulfate mg/L	Dissolved Chloride mg/L	Dissolved Calcium mg/L	Dissolved Magnesium mg/L	Dissolved Sodium mg/L	Dissolved Potassium mg/L	Hardness mg/L as $CaCO_3$	Dissolved Silica mg/L as SIO_2
January	1.8 ± 0.5	57 ± 6	24 ± 4	4.8 ± 0.3	0.6 ± 0.3	6.5 ± 0.6	1.3 ± 0.1	2.2 ± 0.3	0.8 ± 0.1	22 ± 2	4.3 ± 0.9
February	2.2 ± 0.6	57± 4	23 ± 4	4.5± 1.6	0.5 ± 0.2	6.8 ± 0.4	1.3 ± 0.1	2.3± 0.3	0.8 ± 0.1	22 ± 2	4.3 ± 1.0
March	2.4 ± 1.3	60 ± 5	24 ± 3	4.4 ± 1.3	0.5 ± 0.2	7.3 ± 0.7	1.3 ± 0.1	2.3 ± 0.2	0.8 ± 0.1	24 ± 2	4.4 ± 1.0
April	4.3 ± 4.3	54 ± 8	22 ± 5	4.2 ± 1.5	0.4 ± 0.1	6.5 ± 0.6	1.3 ± 0.1	2.3 ± 0.8	0.8 ± 0.1	21 ± 2	4.7 ± 1.1
May	5.3 ± 2.0	47 ± 8	18 ± 6	4.7 ± 1.7	0.5 ± 0.2	5.2 ± 1.3	1.1 ± 0.2	2.3 ± 0.6	0.8 ± 0.2	17 ± 5	7.7 ± 5.0
June	9.9 ± 3.4	33 ± 9	13 ± 4	5.2 ± 1.7	0.4 ± 0.1	4.1 ± 1.1	0.7 ± 0.2	1.8 ± 0.6	0.6 ± 0.2	13 ± 3	4.6 ± 2.1
July	14.0± 2.9	30 ± 10	11 ± 5	3.7 ± 1.5	0.3 ± 0.1	3.2 ± 1.4	0.6 ± 0.3	1.6 ± 0.9	0.4 ± 0.2	10 ± 4	4.0 ± 2.0
August	15.6 ± 1.6	35 ± 10	14 ± 6	3.5 ± 1.7	0.3 ± 0.2	4.2 ± 1.5	0.8 ± 0.3	1.5 ± 0.4	0.5 ± 0.2	14 ± 5	3.5 ± 0.5
September	12.7 ± 1.4	41 ± 8	16 ± 4	3.9 ± 2.1	0.5 ± 0.2	4.8 ± 0.9	1.0 ± 0.2	1.8 ± 0.5	0.7 ± 0.2	16 ± 3	3.8 ± 0.4
October	8.9 ± 1.2	39 ± 7	17 ± 4	4.9 ± 1.4	0.4 ± 0.1	4.8 ± 1.1	0.9 ± 0.2	1.7 ± 0.3	0.6 ± 0.1	14 ± 6	3.8 ± 0.4
November	4.5 ± 1.6	46 ± 7	18 ± 3	5.0 ± 1.8	0.5 ± 0.1	5.5 ± 0.6	1.0 ± 0.1	1.9 ± 0.3	0.7 ± 0.1	18 ± 2	4.1 ± 0.5
December	3.5 ± 0.5	50 ± 6	20 ± 3	4.0 ± 1.6	0.4 ± 0.2	6.1 ± 0.8	1.1 ± 0.2	2.0 ± 0.3	0.7 ± 0.1	20 ± 3	4.3 ± 0.6

Table 2. Micronutrient, physico-chemical, and biological data of Grand Lake water entering the Adams tunnel for transmountain diversion.*

Parameter	Range
Dissolved oxygen (mg/L)	4.8 - 8.5
pH (SU)	6.3 - 7.9
Total phosphate (mg/L)	0.001 - 0.236
Ortho phosphate (mg/L)	0.001 - 0.040
Nitrite and nitrate nitrogen (mg/L)	<0.020 - 0.180
Ammonia nitrogen - total (mg/L)	0.010 - 0.020
Total Kjeldahl nitrogen (mg/L)	0.100 - 0.400
Turbidity (JTU)	0.4 - 1.4
Chlorophyll a (µg/L)	4.0 - 5.5
Transparency - Secchi (cm)	243.8 - 426.7
Primary productivity (mg $C/m^2/hr$)	12 - 43

*Compiled from U.S. Environmental Protection Agency (1970, 1977a, 1977b) and Nelson (1971).

(altitude 1351 mamsl) on the Great Plains about 40 km north of Sterling, Colorado in Logan County. This midge species is normally associated with aquatic macrophytes and not necessarily with freshwater sponges. However, Resh (1976b) reported species of *Glyptotendipes* to feed on the symbiotic green algae within freshwater sponge. All insect material cited in this publication is deposited in the Life Sciences Museum of the University of Southern Colorado.

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